Shri Rawatpura Sarkar University, Raipur

Examination Scheme & Syllabus

for

Two Year Master of Science in Chemistry Programme

M.Sc. Chemistry Semester-II

(Effective from the session: 2022-2023)

Shri Rawatpura Sarkar University
Raipur, Chhattisgarh
Faculty of Science
Department of Chemistry
Two Year Master of Science in Chemistry Programme
M.Sc. Chemistry Semester-II
Scheme of Teaching and Examination

Outcome Based Education (OBC) and Choice Based Credit System (CBCS)
(Effective from the session: 2022-2023)

S. No.	Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			Sem End Exam Duration (Hrs)
			L	T	P		Continuation Evaluation	Semester End Examination	Total	
1	SMS04201T	Inorganic Chemistry II: Transition metal complexes	4	-	-	4	30	70	100	3.0
2	SMS04202T	Organic Chemistry II: Reaction mechanism	4	-	-	4	30	70	100	3.0
3	SMS04203T	Physical Chemistry II:Quantum chemistry, Thermodynamics and chemical dynamics-II se solid state	4	-	-	4	30	70	100	3.0
4	SMS04204T	Theory and Application of Spectroscopy II	4	-	-	4	30	70	100	3.0
5	SMS04281P	Chemistry Lab course: III	-	-	4	2	-	-	50	5.0
6	SMS04282P	Chemistry Lab Course: IV	-	-	4	2	-	-	50	5.0
7	SMS04221T	Research Methodology for Chemistry	2	-	-	2	15	35	50	2.0
	Total teaching hrs/week: 26		**Total Credits**			**22**	**Total Marks**		550	

Course Title	**INORGANIC CHEMISTRY II:TRANSITION METAL COMPLEXES**				
Course Code	**SMS04201T**				
Course Credit	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisite	**Inorganic Chemistry I**				
Objective	• **Inorganic Chemistry in advance and establish foundation to research in the respective domain.**				
Course Content	**UNIT 1** **Reaction Mechanism of Transition Metal Complexes:** Energy profile of a reaction, reactivity of metal complex, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anion reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction. Redox reaction, electron transfer reactions, mechanism of one electron transfer reactions, outer sphere type reactions, cross reactions and marcus-hush theory, inner sphere type reactions. **UNIT II** **Electronic Spectral and Magnetic Properties of Transition Metal Complexes:** Spectroscopic ground states, correlation. orgel and tanabe-sugano diagrams for transition metal complexes (d1-d9 states), selection rule for electronic spectroscopy. Intensity of various type electronic transitions, calculations of 10Dq, B and β parameters, charge transfer spectra. Anomalous magnetic moments, quenching of orbital contribution, orbital contribution to magnetic moment, magnetic exchange coupling and spin crossover. **UNIT III** **Transition metal complexes**: Tranisition metal complexes with unsaturated organic molecules, alkanes, allyl, dienedienyl, arene and trienyl complex, preparations, properties, nature of bonding and structure features. Important reaction relating to nucleophilic and electrophilic attack on ligands and organic synthesis. Transition metals compound with bond to hydrogen. **UNIT IV** **Alkyls andaryls of transition metals:** Types, routes of synthesis, stability and decomposition pathways, organocopper in organic				

	synthesis, **Compounds of** transition metal-carbon multiple bonds: Alkylidenes, low valent carbenes nature of bond and Structural characteristics. Fluxional organometallic compounds: Fluxionality and dynamic equilibria in compounds such as olefin, -allyl and dienyl complexes. **UNIT V** **Organocatalysis**: General Principles: Energetic, Catalytic cycles, catalytic efficiency and life time, selectivity. Type of organometallic reaction: Ligand substitution, Oxidative addition, reductive elimination and insertion and deinsertion. Homogeneous catalysis: Hydrogenetion of alkenes, Hydroformylation, Monsanto acetic acid synthesis, Wacker oxidation of alkenes, Alkenes metathesis, Palladium-Catalysed C-C bond forming reactions, asymmetric oxidation. Heterogenous catalysis: The nature of heterogenous catalysts, Fischer- Tropsch synthesis, alkene polymerization
Course Outcome	• On the completion of this course successfully student will be able to CO 1 : Understand the Reaction Mechanism of Transition Metal Complexes CO 2 : Understand the Electronic Spectral and Magnetic Properties of Transition Metal Complexes CO 3 : know and classified the Transition metal complexes CO 4 : Understand reaction mechanism of Alkyls and aryls of transition metals CO 5 : Learn about the Organocatalysis
Text Books	1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley. 2. Inorganic Chemistry, J.E. Huhey, Harpes and Row. 3. Chemistry of the Elements, N.N. Greenwood and A. Earnshow, Pergamon. 4. Inorganic Electronic Spectroscopy, A.B.P. Lever, Elsevier.
Reference Books	1. Comprehensive Coordination Chemistry Eds. G. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon. 2. Magnetiochemistry, R.1. Carlin, Springer Verlag. 3. Advance Inorganic Chemistry,S.K. Agrawal& K. Lal, PragatiPrakashan

Course Title	**ORGANIC CHEMISTRY II:** REACTION MECHANISM				
Course Code	**SMS04202T**				
Course Credit	**L**	**T**	**P**	**TC**	
	4			**4**	
Prerequisite	**Organic Chemistry: II**				
Objective	• **Organic Chemistry in advance and establish foundation to research in the respective domain.**				
Course Content	**UNIT I** **Reaction Mechanism**: Structure and Reactivity Type of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtir-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotopes effects. Hard and Soft acids and bases. Effect of structure on reactivity resonance and field effects, steric effect, Hammett equation and linear free energy relationship, substitution and reaction constants. **UNIT II** **Aliphatic nucleophilic substitution**: The SN2, SN1, mixed SN1 and SN2 and SET mechanisms. The neighboring group mechanism, neighboring group participation by α and β bonds. The SNi mechanism. Nucleophilic substitution at an allylic aliphatic trigonal and at a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, amoident nucleophile, regioselectivity. Aromatic Nucleophilic Substitution: The SNAr SN1, benzyne and SN1 mechanism, Reactivity effect of substrate structure, leaving group and attacking nucleophile. The Von Richte, Sommelet-Hauser and Smiles rearrangements **UNIT III** **Alipahatic electrophilic substitution**: Bimolecular mechanism SE2, SEi and SEI mechanism electrophilic substitution acompanied by double bond shifts. Effect of substrates, leaving group and the				

	solvent polarity on the reactivity. Aromatic Electrophilic Substitution: The treniumion mechanism, orientation and reactivity, energy profile diagrams. The ortholpara ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Gatterman-Koch reaction, Vilsmeir reaction. **UNIT IV** **Addition to Carbon-Hetero:** Multiple bonds mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acid esters and nitriles. Addition of grignard reagents, organozinc and organolithium reagents to carbonyl and usaturated carbonyl compounds. Witting reaction. Mechanism of condensation reactions involving enolates-aldol, knoevenagel, claisen, mannich, benzoin, perkin and stobbe reactions. Hydrolysis of esters and amides, ammonolysis of ester. **UNIT V** **Addition to Carbon Multiple** bonds addition to cyclopropane ring. hydrogenation of double and triple bounds, hydrogenation of aromatic rings. hydroboration, michael reaction, sharpless asymmetric epoxidation. Elimination Reactions The E2, E1 and E1cB mechanisms and their spectrum. Orientation of the double bond. Reactitivty-effects of substrate structures, attacking base, the leaving group and the medium.
Course Outcome	• On the completion of this course successfully student will be able to understand CO 1 : The Reaction Mechanism and its method of determination CO 2 : nucleophilic substitution and its mechanism CO 3 : electrophilic substitution and its mechanism CO 4 : Mechanism of Multiple bonds and condensation reactions CO 5 : The hydrogenation of aromatic rings.

Text Books	1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley. 2. Advanced Organic Chemistry, F.A. Carey and R.J. Sunderg, Plenum. 3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman. 4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Comell University Press. 5. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentice-Hall.
Reference Books	1. Modern Organic Reactions, H.O. House, Benjamin. 2. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic &Professionsl. 3. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan. 4. Pericyclic Reactions, S.M. Mukherji, Macmillan, India 5. Stereochemistry of Organic Compounds, D.Nasipuri, New Age International.

Course Title	**PHYSICAL CHEMISTRY II:** QUANTUM CHEMISTRY, THERMODYNAMICS AND CHEMICAL DYNAMICS-II AND SOLID STATE				
Course Code	**SMS04203T**				
Course Credit	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisite	**Physical Chemistry: I**				
Objective	• **Physical Chemistry in advance and establish foundation to research in the respective domain.**				
Course Content	**UNIT I** **Angular Momentum:** Ordinary angular momentum, generalized angular momentum, eigen functions for angular momentum, eigenvalues of angular momentum operator using ladder operators addition of angular momenta, spin, antisymmetry and Pauli exclusion principle. Molecular Orbital Theory**:** Huckel theory of conjugated systems bond and charge density calculations. Applications to				

	ethylene, butadiene, cyclopropenyl radical cyclobutadiene etc. Introduction to extended huckel theory. **UNIT II** **Statistical Thermodynamics:** Concept of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging. Canonical, grand canonical and micro-canonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers). Partition functions-translation, rotational, vibrational and electronic partition functions, Calculation of thermodynamic properties in terms of partition. Application of partition functions. Fermi-Dirac Statistics, distribution law and applications to metal. Bose-Einstein statistics distribution Law and application to helium. **UNIT III** **Chemical Dynamics II:** General features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis ad the nuclear magnetic resonance method, dynamics of unimolecular reactions (Lindemann Hinshelwood and Rice Ramsperger-Kassel-Marcus (RRKM) theories for unimolecular reactions). Electrochemistry II: Semiconductor interfaces-theory of double layer at semiconductor, electrolyte solution interfaces, structure of double layer interfaces. Effect of light at semiconductor solution interface Electrocatalysis - influence of various parameters. Hydrogen electrode. **UNIT IV** **Macromolecules Polymer:** definition, types of polymers, electrically conducting, fire resistant, liquid crystal polymers, kinetics of polymerization, mechanism of polymerization. Molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry, diffusion and light scattering methods), sedimentation, chain configuration of macromolecules, calculation of average dimension of various chain structures. **UNIT V** **Crystal Defects and Non-Stoichiometry:** Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects, line and plane defects, vacancies-Schottky detects and Frenkel defects. Thermodynamics of Schottky and Frenkeldefect formation, colour centres, non-stoichiometry and defects. **Electronic Properties and Band Theory:** Metals insulators and semiconductors, electronic structure of solid band theory band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, doping semiconductors, p-n junctions, super conductors. Optical properties - Optical reflectance, photoconduction photoelectric effects.

<table>
<tr><td>Course Outcome</td><td colspan="5">• On the completion of this course successfully student will be able to
CO 1 : Understand the Angular Momentum and its applications
CO 2 : Understand the Concept of distribution, thermodynamic probability and most probable distribution
CO 3 : Study of fast reactions and its methods
CO 4 : Learn about the Macromolecules Polymer
CO 5 : Determine the Crystal Defects and Band Theory.</td></tr>
<tr><td>Text Books</td><td colspan="5">1. Physical Chemistry, P.W. Atkins, ELBS.
2. Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
3. Quantum Chemistry, Ira N. Levine, Prentice Hall.
4. Coulson’s Valence, R.McWeen y, ELBS.</td></tr>
<tr><td>Reference Books</td><td colspan="5">1. Chemical Kinetics. K.J. Laidler, McGraw-Hill.
2. Kinetics and Mechanism of Chemical Transformation J.Rajaraman and J. Kuriacose, McMillan.
3. Micelles, Theoretical and Applied Aspects, V. MOraoi, Plenum.
4. Modern Electrochemistry Vol. 1 and Vol II J.O.M. Bockris and A.K.N. Reddy, Planum.
5. Introduction to Polymer Science, V.R. Gowarikar, N.V. Vishwanathan and J. Sridhar, Wiley Eastern.</td></tr>
<tr><td>Course Title</td><td colspan="5">THEORY AND APPLICATION OF SPECTROSCOPY II</td></tr>
<tr><td>Course Code</td><td colspan="5">SMS04204T</td></tr>
<tr><td rowspan="2">Course Credit</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>4</td><td>-</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisite</td><td colspan="5">Theory and Application of Spectroscopy I</td></tr>
<tr><td>Objective</td><td colspan="5">• Theory and Application of Spectroscopy I</td></tr>
<tr><td>Course Content</td><td colspan="5">UNIT I
Ultraviolet and visible spectroscopy:-Introduction, intensity of</td></tr>
</table>

	vibrational-electronic spectra and Frank-Condon principle for dissociation energy, rotational fine structure of electronic-vibrational spectra, Shape of some molecular orbitals viz., H_2, He_2, N_2, O_2. Electronic spectra of organic molecules, chromophores, application of electronic spectroscopy: spectrophotometric studies of complex ions, determination of ligand/metal ratio in a complex, identification of compounds, determination stability constants. **UNIT II** **Infra red spectroscopy:-**Introduction, simple and anharmonic oscillators in vibrational spectroscopy, diatomic-vibrating rotator, Modes of vibration in polyatomic molecules, vibration-coupling, Fourier Transform IR spectroscopy: instrumentation, interferometric spectrophotometer, sample handling, Factors influencing vibrational frequencies, Application of IR spectroscopy: Interpretation of IR spectraof normal alkanes, aromatic hydrocarbons, alcohols and phenols aldehydes and ketones, ethers, esters, carboxylic acids and amines and amides **UNIT III** **Mass spectrometry:-**Introduction, basic principles, separation of the ions in the analyzer, resolution, molecular ion peak, mass spectral fragmentation of organic compounds, factors affecting fragmentation, McLafferty rearrangement. Instrumentation, Characteristics of mass spectra of Alkanes, Alkenes, Aromatic hydrocarbons, Alcohols, Amines. Nitrogen rule, ring rule, Molecular weight and formula determination, Gas chromatography-Mass spectrophotometry: Introduction. **UNIT IV** **Nuclear resonance spectrophotometry:-**Theory of NMR spectroscopy, interaction of nuclear spin and magnetic moment, chemical shift, processional motion of nuclear particles in magnetic field, spin-spin splitting, coupling constants, factor affecting the chemical shift, shielding effect, effect of chemical exchange, hydrogen bonding, instrumentation of Fourier transform NMR spectrophotometer, structure determination of organic compounds, Carbon-13 NMR spectroscopy, Multiplicity-proton (1H) decoupling-noise decoupling, offresonance decoupling, selective proton decoupling, chemical shift. **UNIT V** **Electron Spin Resonance Spectroscopy:** Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensors, application to transition metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals such as PH4, F2 and [BH3]. **Mossbauer Spectroscopy:** Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1)

	bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, (2) Sn^{+2} and sn^{+4} compounds - nature of M-L bond, -coordination number, structure and (3) detection of oxidation state and in equivalent MB atoms
Course Outcome	• On the completion of this course successfully student will be able to CO 1 : Understand the principles of Ultraviolet and visible spectroscopy and its application CO 2 : Understand the principle of Infra red spectroscopy and its instrumentation CO 3 : The instrumentation method Mass spectrometry and its application. CO 4 : Understand Nuclear resonance spectrophotometry and its application. CO 5 : Gain the knowledge of Electron Spin Resonance Spectroscopy and Mossbauer Spectroscopy
Text Books	1. Modern Spectroscopy, J.M. Hollas, John Viley. 2. Applied Electron Spectroscopy for chemical analysis d. H. Windawi and F.L. Ho, Wiley Interscience. 3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood. 4. Physical Methods in Chemistry, R.S. Drago, Saunders College.
Reference Books	1. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill. 2. Basic Principles of Spectroscopy, R. Chang, McGraw Hill. 3. Theory and Application of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBHOxford. 4. Introduction to Photoelectron Spectroscopy, P.K. Ghosh, John Wiley. 5. Introduction to Magnetic Resonance. A Carrington and A.D. Maclachalan, harper & Row.

Course Title	**CHEMISTRY LAB COURSE: III**				
Course Code	**SMS04281P**				
Course	**L**	**T**	**P**	**TC**	

Credit	-	-	2	2	
Prerequisite	**Chemistry Lab Course: I**				
Objective	• **To understand the practical concepts of inorganic and organic chemistry**				
Course Content	1. Simple distillation, steam distillation, fractional distillation and distillation under reduced pressure. 2. General methods of separation and purification of organic compounds with special reference to: a. Solvent Extraction b. Fractional Crystallisation Distillation techniques 3. Analysis of organic binary mixture:- Separation and Identification of organic binary mixtures containing at least one component with two substituents. (A student is expected to analyse at least 10 different binary mixtures.) 4. Preparation of organic compounds single stage preparation (Any five). a. Acetylation: Synthesis of β-Naphthyl acetate from β-Naphthol / Hydroquinonediacetate from Hydroquinone. b. Aldol condensation: Dibenzal acetone from benzaldehyde. c. Bromination: p-Bromoacetanilide from acetanilide. d. Cannizzaro Reaction: Benzoic acid and Benzyl alcohol from benzaldehyde. e. Friedel Crafts Reaction: O-Benzoyl Benzoic acid from phthalic anhydride. f. Grignard Reaction: Synthesis of triphenylmethanol from benzoic acid. g. Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol. h. Perkin's Cinnamic Reaction: acid from benzaldehyde. i. Sandmeyer Reaction: p-Chlorotoluene from p-toluidine/o-Chlorobenzoic acid from anthranilic acid. j. Schotten Baumann Reaction: β-Naphthyl benzoate from:β-Naphthol / Phenyl benzoate from phenol. Sulphonation Reaction: Sulphanilic acid from aniline.				
Course Outcome	• On the completion of this course successfully student will be able to				

	CO 1 : Determine methods of separation and purification of organic compounds CO 2 : Analysis of organic binary mixture CO 3 : Perform synthesis the Aldol condensation reaction. CO 4 : Synthesis of Grignard Reaction CO 5 : Perform the Oxidation experiment
Text Books	1. Vogel's Textbook of Quantitative Analysis, revi Mendham, ELBS. 2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall. 3. Practical Organic chemistry by A. I. Vogel. 4. Practical Organic chemistry by Mann and Saunders. 5. Practical Organic chemistry by Garg and Salija.
Reference Books	1. The Systematic Identification of Organic compounds, R. L. Shriner and D. Y. Curtin. 2. Semimicro Qualitative Organic Analysis, N.D. Cheronis, J. B. Entrikin and E. M. Hodnett. 3. Practical Physical chemistry by Alexander Findlay. 4. Experimental Physical chemistry, D. P. Shoemaker, G. W. Garland and J. W. Niber, McGraw Hill Interscience. Findlay's Practical Physical chemistry, revised B

Course Title	**CHEMISTRY LAB COURSE: IV**				
Course Code	SMS04282P				
Course Credit	**L**	**T**	**P**	**TC**	
	-	**-**	**2**	**2**	
Prerequisite	**Chemistry Lab Course: II**				
Objective	• **To understand the practical concepts of spectroscopy and physical chemistry**				

Course Content	1. Flame photometric determinations a. Sodium and potassium when present together. b. Sodium/potassium in solid samples. c. Solid Sodium and Potassium in Liquid Samples. d. Lithium/calcium/barium/strontium. e. Cadmium and magnesium in tap water. 2. Nephelometric determinations 1. Sulphate 2. Phosphate 3. Silver 3. Spectroscopy a. Verification of Beer's Lambert Law. b. Determination of stoichiometry and stability constant of inorganic (e.g. ferric–salicylclic acid) and organic (e.g. amine-iodine) complexes, thiocynam. c. Characterization of the complexes by electronic and IR, UV spectral data. d. Determination of Indicator constant (pKa) of methyl redin (i) aqueous and (ii) micellar media.
Course Outcome	On the completion of this course successfully student will be able to CO 1 : Determine the heavy metals with the help of Flame photometer. CO 2 : Nephelometric determinations of sulphate, phosphate and silver. CO 3 : Verification of Beer's Lambert Law. CO 4 : Determination of stoichiometry and stability constant of inorganic complex CO 5 : Determination of Indicator constant.
Text Books	1. Experiments and Techniques in Organic Chemistry, D.Pasto, C. Johnson and M.Miller, Prentice Hall. 2. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath. 3. Systematic Qualitative Organic Analysis, H. Middleton, Adward

	Arnold. Handbook of Organic Analysis –Qualitative and Quantitative, H. Clark, Adward Arnold. 4. Vogel's Textbook of Practical Organic Chemistry, 5. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
Reference Books	1. Findley's Practical Physical Chemistry, B.P. Levi 2. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill. 3. Computer and Common Sense, R. Hunt and J. Shelley, Prentice Hall. 4. Computational Chemistry, A.C. Norris. 5. Microcomputer Quantum Mechanics, J.P. Killngbeck, Adam Hilger. 6. Computer Programming in FORTRAN IV, V. Rajaraman, Prentice Hall. 7. An Introduction to Digital Computer Design, V. Rajaraman and T. Radhakrishnan, Prentice Hall. 8. Experiments in Chemistry, D.V. Jahagirgar.

Course Title	**RESEARCH METHODOLOGY FOR CHEMISTRY**				
Course Code	SMS04221T				
Course Credit	**L**	**T**	**P**	**TC**	
	2	**-**	**-**	**2**	
Prerequisite	**Students must appears in end semester examination of M.Sc. Chemistry**				
Objective	• **Identify and discuss the concepts and procedures of sampling, data collection, analysis and reporting.**				
Course Content	**UNIT I** Introduction, Biological data, Collection of data, Processing of data, Primary and Secondary data, Frequency distribution – Discrete and Continuous. Cumulative frequency distributions. **UNIT II**				

	Diagrammatic and graphic representation of data: Advantages, Disadvantages; Types: Line diagram, Bar diagram, Pie Chart, Histogram, Frequency polygon, Frequency Curve. **UNIT III** Central tendency: Mean, Median, and Mode. Measures of dispersion – Standard Error, Standard deviation and Coefficient of Variations. Random Variable: Expectation and variance. **UNIT IV** Research Methodology: Introduction, Meaning, Objectives of Research, Motivation in Research, Types of Research, Significance of Research, Research Methods versus Research Methodology. **UNIT V** Research and Scientific Method, Process of Research, Criteria of Good Research, Limitations of Research, Research Problem: Definition, Selection and Techniques; Interpretation, Technique of Interpretation, Report writing.
Course Outcome	On the completion of this course successfully student will be able to CO 1: understand the concepts and procedures of sampling, data collection, analysis and reporting. CO2: gain Knowledge about Diagrammatic and graphic representation of data CO3: use the appropriate statistical methods required for a particular research design CO4: understand various steps involved in conducting research. CO5: research design and develop appropriate research hypothesis for a research project
Text Books	1. Research Methodology: Dr. V Upagade and Dr.Arvind Shende
Reference Books	1. Research Methodology: Methods and Techniques: C R Kothari